CLAIMS

1. An alternator system, having an alternating current (ac) voltage source having at least one rotor, said ac voltage source having an output voltage controllable by a field current thereof and an output, said alternator system comprising:

a switched-mode rectifier (SMR) coupled to the ac voltage source and having an output port coupled to an output of the alternator system; and

a controller coupled to said switched-mode rectifier so as to provide a controlled pulse sequence synchronized with an angular rotor position of the ac voltage source to activate and deactivate said switched-mode rectifier.

2. The system of Claim 1 wherein the controller comprises a PWM generator having a first input adapted to receive a total duty ratio signal synchronized with an angular rotor position of the ac voltage source.

3. The system of Claim 2 wherein the controller further comprises:

a bounded summation circuit having a first input, a second input, and an output coupled to the first input of the PWM generator;

a base duty ratio generator coupled to the first input of the bounded summation circuit; and

a timing duty ratio generator coupled to the second input of the bounded summation circuit

4. The system of Claim 3 wherein the timing duty ratio generator comprises a first input coupled to an output of a timing reference circuit adapted to receive a timing reference event signal synchronized with the angular rotor position of the ac voltage source.

5. The system of Claim 4 wherein the timing reference event signal is provided by one of:

a detection of a polarity change in a phase current of said voltage source;

a given count from a position encoder coupled to a shaft of the rotor of said voltage source; and

a polarity of the voltage across the switched-mode rectifier.

6. The system of Claim 1 wherein the controlled pulse sequence comprises a plurality of intervals, the plurality of intervals repeating at a fundamental electrical frequency of said voltage source, each such interval having an adjustable duration and comprising a pulse width modulation (PWM) signal provided by a PWM generator having an input coupled to a summation of a base duty ratio signal having a duty cycle adjustable from zero to unity and a timing duty ratio signal synchronized with the angular rotor position of the ac voltage source.

7. The system of Claim 1 wherein a timing reference pulse of the controlled pulse sequence is triggered by an adjustable delay initiated by an event related to a fundamental electrical frequency of said voltage source.

8. The system of Claim 1 wherein the controlled pulse sequence comprises a plurality of intervals, the plurality of intervals repeating at a fundamental electrical frequency of said voltage source, each such interval having an adjustable duration and comprising the logical combination of a pulse width modulation (PWM) signal having a duty cycle adjustable from zero to unity and a timing reference pulse signal having a predetermined pulse duration interval less than a fundamental electrical period of said voltage source.

9. The system of Claim 8 wherein an initial one of the plurality of intervals is aligned with a timing reference event signal, the pulse signal duration of the initial interval has a zero duration, such that the initial interval provides a pulse delay interval having a predetermined duration, such that a first timing reference pulse signal of the plurality of intervals occurs after the pulse delay interval following the reference signal

timing event signal.

10. The system of Claim 9 wherein the timing reference event signal is provided by one of:

a detection of a polarity change in a phase current of said voltage source;

a given count from a position encoder coupled to a shaft of the rotor of said voltage source; and

a polarity of the voltage across the switched-mode rectifier.

11. The system of Claim 1 wherein said controller comprises a microprocessor.

12. The system of Claim 1 wherein said controller is a programmable microprocessor operable in response to stored program instructions; and said alternator system further comprises a lookup table which can be interrogated by said programmable microprocessor, to provide information in response to said event, for selectively generating said controlled pulse sequence.

13. The system of Claim 1 wherein said controller comprises:

a pulse timing reference circuit;

a timing reference pulse generator coupled to said pulse timing reference circuit; and

a logic element having a first input coupled to an output of said timing reference pulse generator, and having an output coupled to said switched-mode rectifier.

14. The system of Claim 13 wherein said controller further comprises a base duty ratio pulse width modulation (PWM) generator having an output coupled to a second input of said logic element.

15. The system of Claim 14 wherein the pulse sequence further comprises a plurality of adjustable time periods, wherein each of the plurality of adjustable time periods

comprises the output of the base duty ratio PWM generator operating at a predetermined duty ratio for the respective period.

16. The system of Claim 14 wherein said base duty ratio PWM generator has an input coupled to a sensor which senses a parameter of a first one of said ac voltage source and an engine and in response thereto said sensor provides a signal representative of the parameter to said base duty ratio PWM generator.

17. The system of Claim 16 wherein in response to signal information provided thereto, said base duty ratio PWM generator provides a base duty ratio PWM signal to said logic element which causes the switched-mode rectifier to operate with a particular duty cycle selected to provide a controlled transformation of voltage and current between terminals of the ac voltage source and output terminals of the alternator system and to convert an ac voltage from the ac voltage source to a direct current (dc) voltage.

18. The system of Claim 16 wherein said sensor senses at least one of an ac voltage source speed, an ac voltage source fundamental electrical frequency, and an ac voltage source back emf.

19. The system of Claim 18 wherein said sensor comprises:

a sense winding electromagnetically coupled to the alternating current ac voltage source; and

a back emf detection circuit.

20. The system of Claim 16 wherein said sensor is coupled to an engine and said sensor senses at least one of an engine speed, and an engine frequency.

21. The system of Claim 1 further comprising a field controller comprising:

an input port coupled to an output of the controller; and

an output port coupled to an input port of a field current regulator to provide the

field current to said ac voltage source.

22. The system of Claim 22 wherein in response to a sensed output voltage being less than a reference value the controller provides a first output signal to increase the field current to said ac voltage source.

23. The system of Claim 21 further a sensor, said controller sensing an output voltage level at the output of said alternator system, and comparing the sensed output voltage level to a reference value, and providing control signals to said field controllerin response to the comparison.

24. The system of Claim 22 wherein in response to the sensed output voltage being less than the reference value the controller provides a first output signal to increase the field current to said ac voltage source.

25. The system of Claim 1 further comprising a fault protection controller having an input port coupled to an output of the alternator system and having an output port coupled to an input of said controller.

26. The system of Claim 1 further comprising a thermal sensor disposed on the ac voltage source and having an output port coupled to a thermal sensor input port of said controller.

27. A method for controlling an alternator having an alternating current (ac) voltage source, an output voltage controllable by a field current thereof and having a rectifying circuit including a switched mode rectifier, the method comprising:

sensing an event synchronized with an angular rotor position of the ac voltage source;

generating a controlled pulse sequence in response to sensing the event; and

providing said controlled pulse sequence to control the switched mode rectifier.

28. The method of Claim 27 wherein generating a controlled pulse sequence comprises:

providing a base duty ratio signal;

providing a timing duty ratio signal;

summing the base duty ratio signal and timing duty ratio signal to provide a total duty ratio signal; and

generating a PWM signal having the total duty ratio.

29. The method of Claim 27 wherein said event is a timing mark derived from at least one of engine speed, engine frequency, an alternating current (ac) voltage source speed, an ac voltage source frequency and an ac voltage source back emf.

30. A rectifier circuit for a multi-phase alternator having at least one phase winding output, the rectifier circuit comprising:

at least one connection for receiving the respective at least one phase winding output;

a positive output terminal;

at least one first diode having a cathode connected to said positive output terminal and an anode connected to a respective one of said at least one phase winding outputs;

at least one second diode having a cathode connected to the respective one of said at least one of said phase winding outputs and an anode connected to a reference potential; and

at least one reactive device having a first port connected between a respective one of the at least one phase winding outputs and having a second port coupled to a second connection such that conduction times for said first and second diodes are modified resulting in increased output power.

31. The rectifier circuit of Claim 30 wherein said reactive device comprises a capacitor.

32. The rectifier circuit of Claim 30 wherein the second connection comprises one of:

the reference potential;

the positive output terminal; and

a respective phase winding output.

33. The rectifier circuit of Claim 30 further comprising more than one reactive devices wherein the second ports of the more than one reactive devices are connected together to form the second connection.

34. The rectifier circuit of Claim 30 wherein said reference potential comprises ground.

35. The rectifier circuit of Claim 30 wherein the rectifier circuit further comprises a negative output terminal and said reference potential comprises the negative output terminal.

36. A rectifier circuit for a multi-phase alternator having an alternating current (ac) voltage source, a neutral leg and at least one phase winding output, the rectifier circuit comprising:

a plurality of connections for receiving the at least one phase winding output;

a positive output terminal;

a first diode having a cathode connected to said positive output terminal and an anode connected to the neutral leg;

a second diode having a cathode connected to neutral leg and an anode connected to a negative output terminal; and

at least one reactive device having a second port coupled to the neutral leg and a first port in selective electrical communication with a respective at least one reference potential.

37. The system of Claim 36 further comprising:

at least one switch having a control terminal, a first terminal switchably connected to the first port of a respective at least one reactive device; and

a controller adapted to control said switch such that at least one reactive element can be selectively coupled between the neutral leg and the respective at least one reference potential when said ac voltage source reaches a predetermined rotational speed, such that conduction times for at least one of the first and second diodes are modified resulting in increased output power.

38. The rectifier circuit of Claim 36 wherein the respective at least one reference potential comprises at least one of:

a ground reference potential;

the negative output terminal; and

the positive output terminal.

39. The rectifier circuit of Claim 36 wherein the negative output terminal is a ground reference potential.

40. A rectifier circuit for a multi-phase alternator having a neutral leg and at least one phase winding output, the rectifier circuit comprising:

a plurality of connections for receiving the at least one phase winding output;

a rectifier having a positive terminal and a negative terminal, coupled to said ac voltage source;

a controller so as to provide a controlled pulse sequence;

a first switch having a first terminal coupled to the neutral leg and having a second terminal coupled to a first reference potential; and

wherein said first switch is coupled to said controller, such that the controller activates and deactivates said first switch.

41. The rectifier circuit of Claim 40 wherein the first switch comprises a metal oxide semiconductor field effect transistor (MOSFET).

42. The rectifier circuit of Claim 40 wherein the respective first reference potential comprises at least one of:

a ground reference potential;

the negative output terminal; and

the positive output terminal.

43. The rectifier circuit of Claim 40 further comprising a second switch coupled to the neutral leg and having an output port coupled to a second reference potential such second reference potential being different from the first reference potential; AND

wherein said second switch is coupled to said controller, such that the controller activates and deactivates said first and second switches.

44. The rectifier circuit of Claim 43 wherein the first and second reference potentials comprise at least one of:

the negative output terminal; and

the positive output terminal.

45. The rectifier circuit of Claim 43 wherein the first switch comprises a metal oxide semiconductor field effect transistor (MOSFET) and the second switch comprises a MOSFET.

46. The rectifier circuit of Claim 40 wherein the first switch comprises a diode.

47. The rectifier circuit of Claim 43 wherein the second switch comprises a diode.

48. A rectifier circuit for a multi-phase alternator having an alternating current (ac) voltage source, a neutral leg and at least one phase winding output, the rectifier circuit comprising:

a plurality of connections for receiving the at least one phase winding output;

a rectifier having an output voltage port, at least one first diode and at least one

second diode, a cathode of the at least one first diode coupled to an anode of a respective at least one second diode;

a circuit coupled to the output voltage port, said circuit comprising:

at least one reactive device having a first port and a second port coupled to coupled to an anode of the respective at least one second diode;

at least one switch having a control terminal, a first terminal coupled to the first port of a respective at least one reactive device and a second terminal coupled to a reference potential;

a controller having an input terminal coupled to an output of a sensor, adapted to control said at least one switch such that a respective at least one reactive element can be selectively coupled between each of a respective phase winding output and the reference potential when said ac voltage source reaches a predetermined rotational speed, such that conduction times for the plurality of first and second diodes are modified resulting in increased output power.

49. The rectifier circuit of Claim 48 wherein said reactive device comprises a capacitor.

50. The rectifier circuit of Claim 48 wherein said sensor senses at least one of:

an ac voltage source speed;

an ac voltage source fundamental electrical frequency;

an ac voltage source back emf; and

a rectifier output voltage.

51. The rectifier circuit of Claim 48 wherein the reference potential comprises at least one of:

the negative output terminal; and

the positive output terminal.